

MRO CRISM TRR3 Hyperspectral Data Filtering

CRISM Data User's Workshop
03/18/12

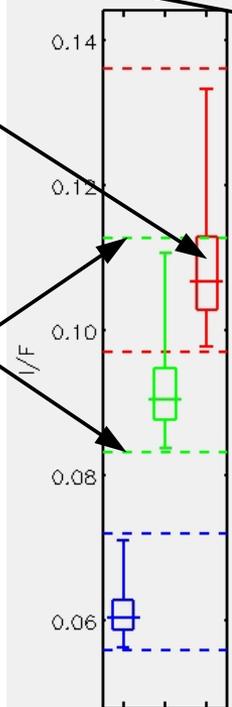
F. Seelos, CRISM SOC

False Color RGB Composite

FRT0000C202 CRISM VNIR Composite

Composite band distribution box plot

Composite band stretch limits

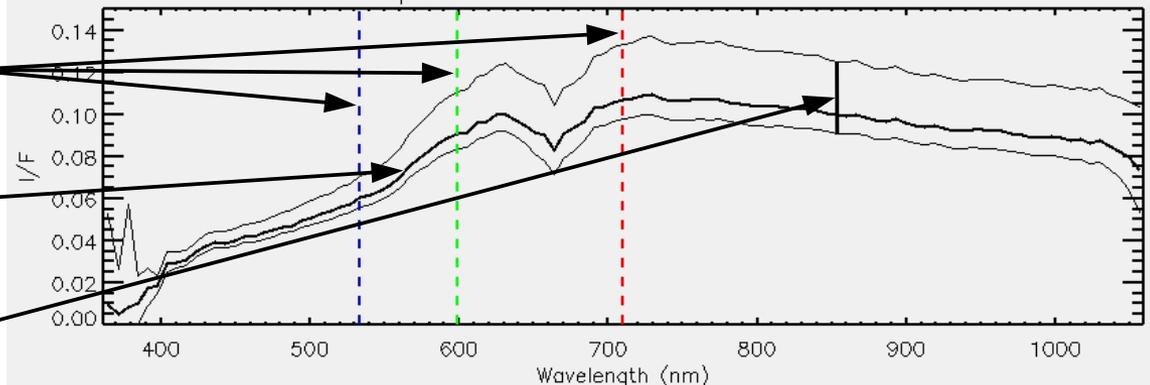


Composite RGB bands

Scene median spectrum

Spectral percentile envelope
(1st - 99th percentile)

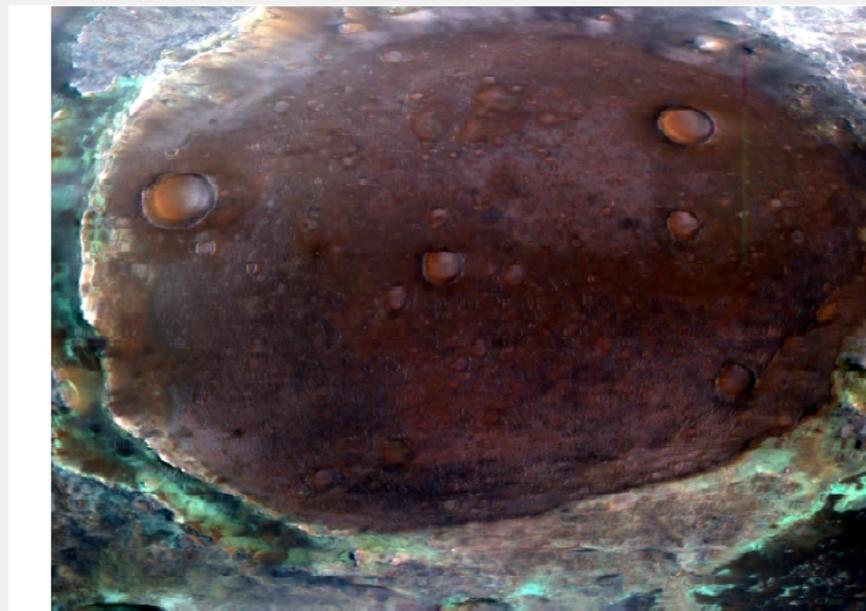
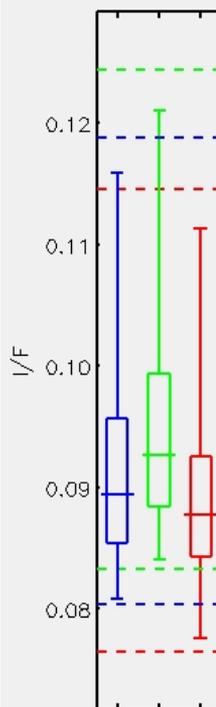
Spectral Median & Percentile Interval



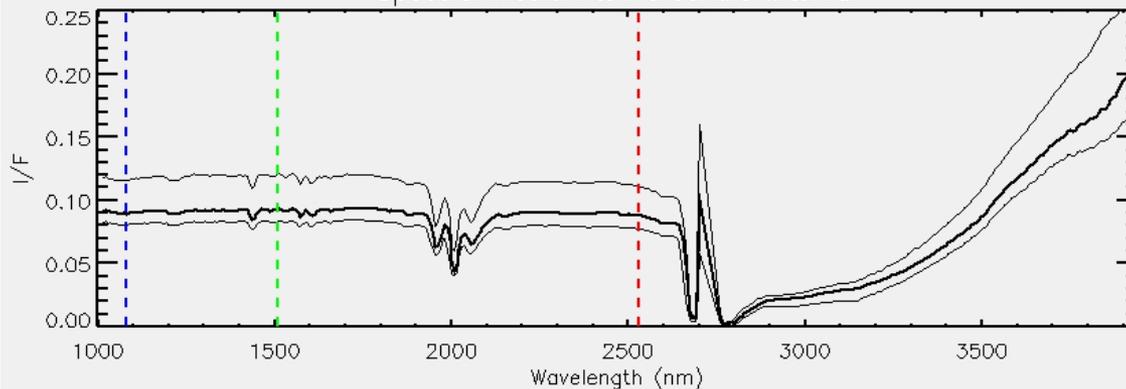
Product Summary

Instrument Host ID	MRO
Instrument ID	CRISM
Product Type	TRDR
Observation Type	FRT
Observation ID	16#0000C202#
Observation Number	16#07#
Observation Time	2008-08-21T17:21:57.661
UTC Start Time	2008-08-21T17:20:57.794
UTC Stop Time	2008-08-21T17:22:57.529
Orbit Number	9705
Center Latitude	21.269
Center Longitude	73.373
Maximum Latitude	21.378
Minimum Latitude	21.159
Westernmost Longitude	73.245
Easternmost Longitude	73.501

FRT0000C202 CRISM IR Composite

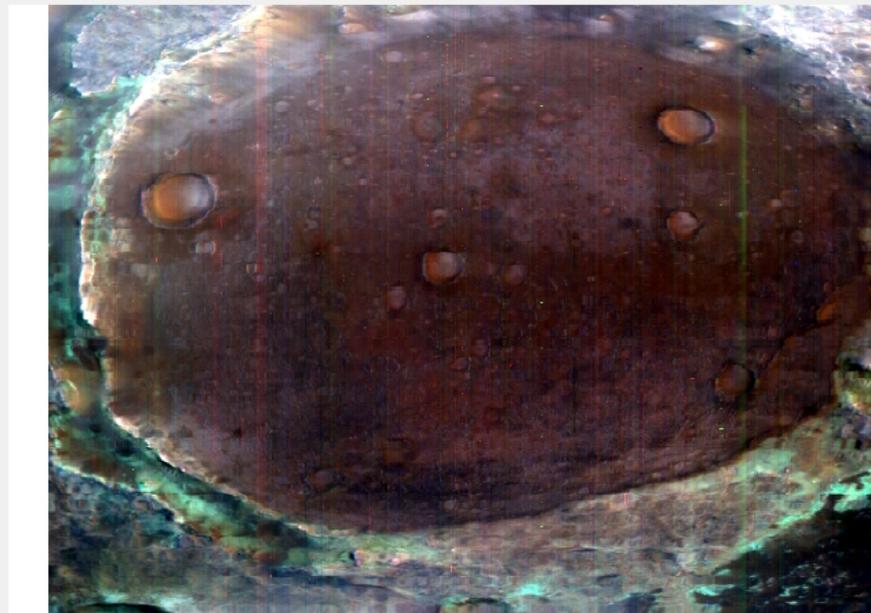
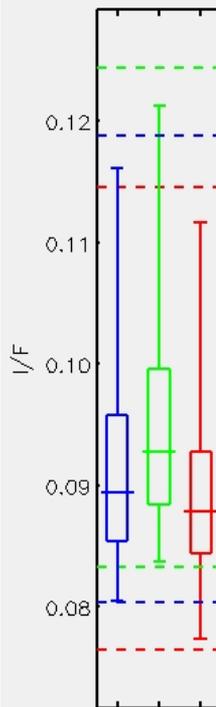


Spectral Median & Percentile Interval

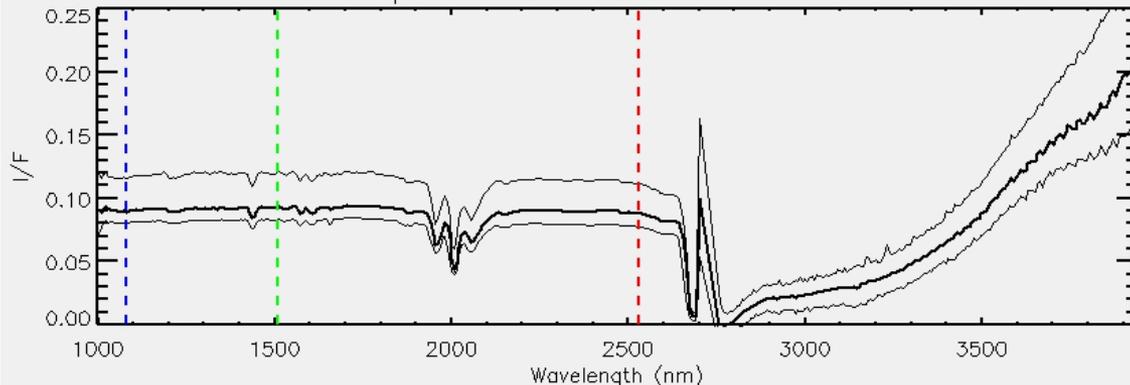


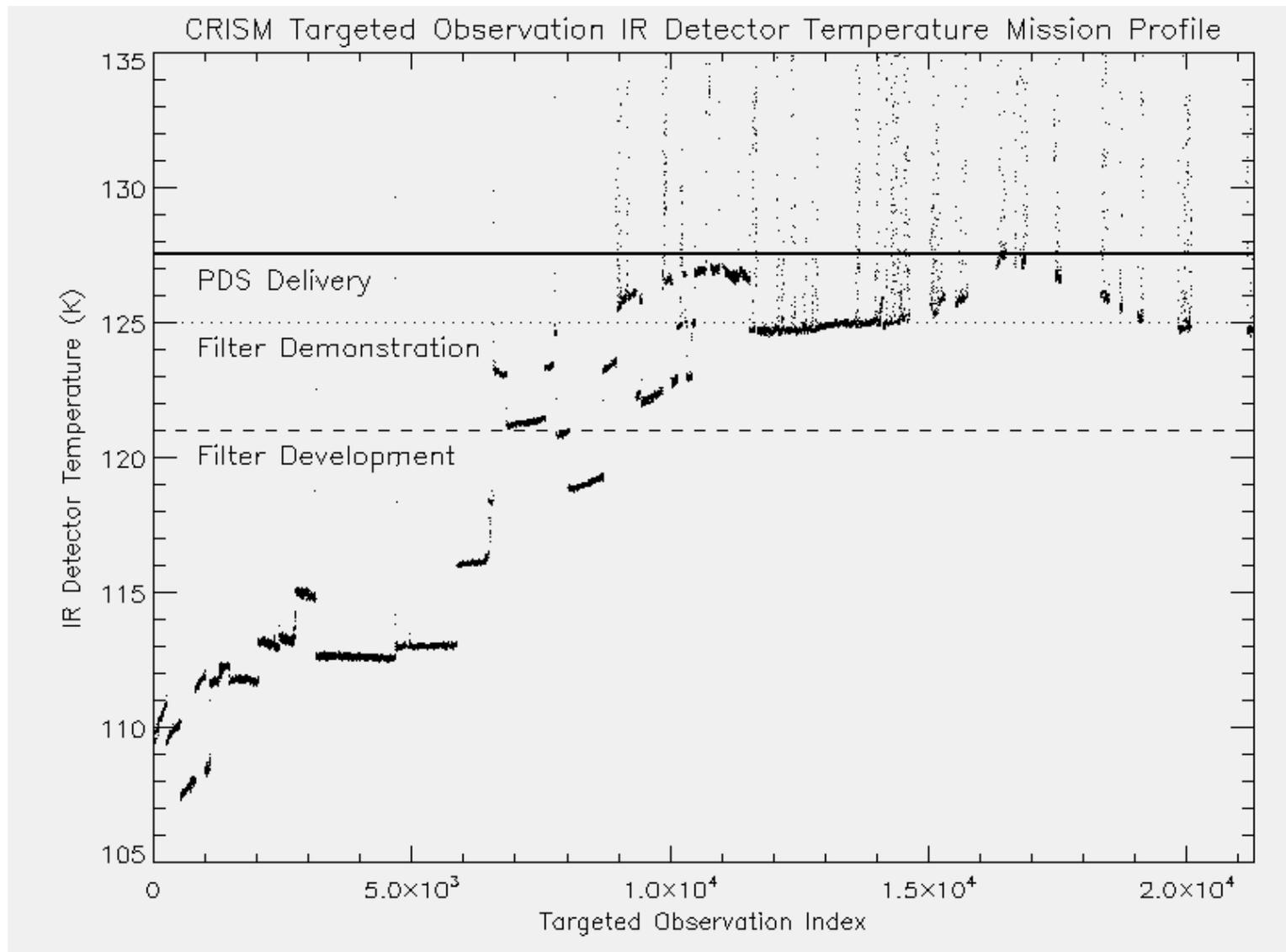
- IR detector temperature is the most significant driver for both systematic and stochastic noise in the CRISM IR data set
- Systematic noise appears in the ground plane as along-track striping
 - Time invariant (over the duration of the observation) calibration residual related to a specific [spatial, spectral] pixel on the IR detector
- Stochastic noise appears as data spikes with limited spatial and spectral extent and as time dependent (over the duration of the observation) variability in detector element responsivity
- The hyperspectral data filtering procedure seeks to isolate and mitigate these noise components without adversely impacting the spatial/spectral information content of the observation

FRT0000C202 CRISM IR Composite



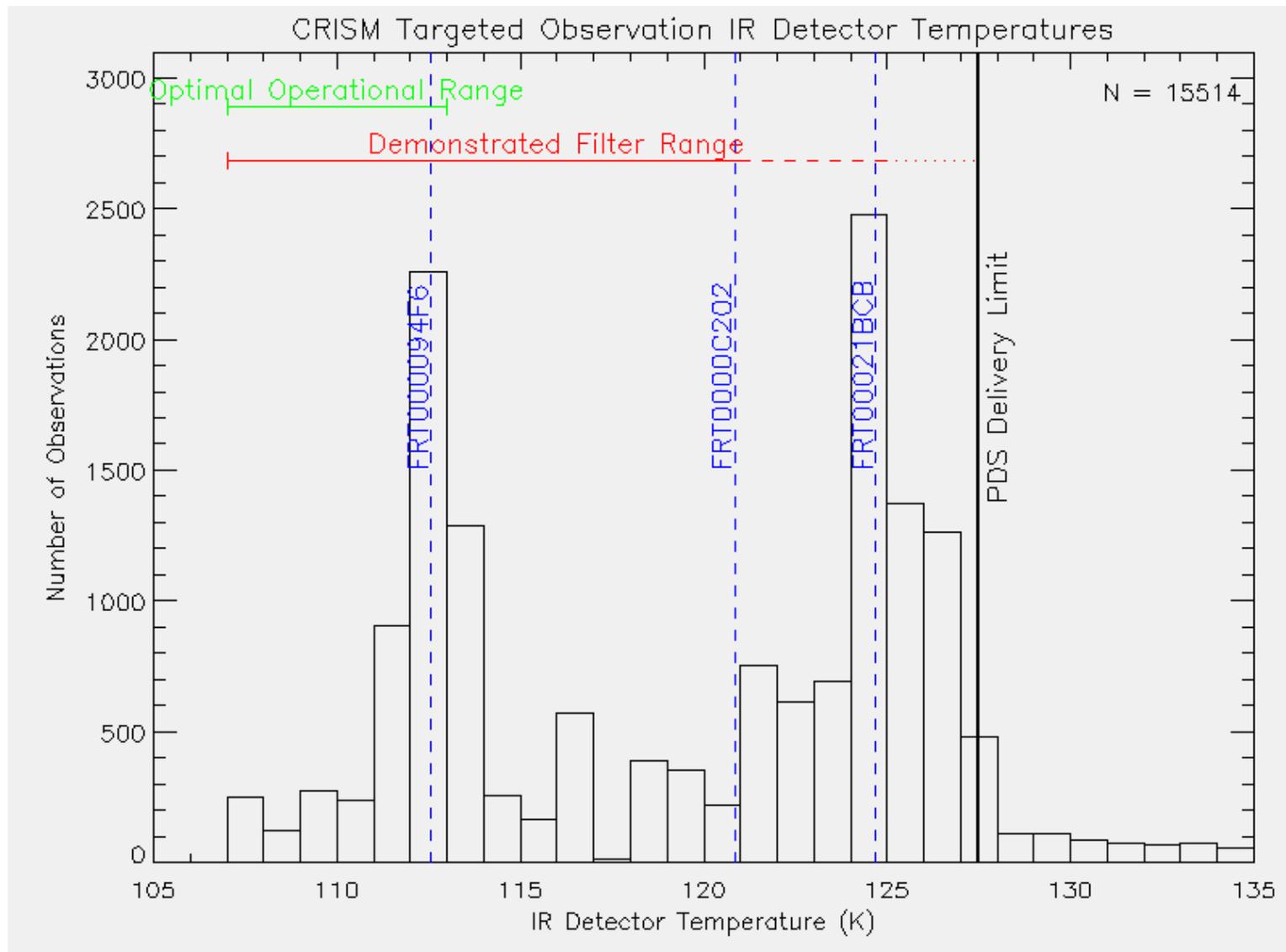
Spectral Median & Percentile Interval

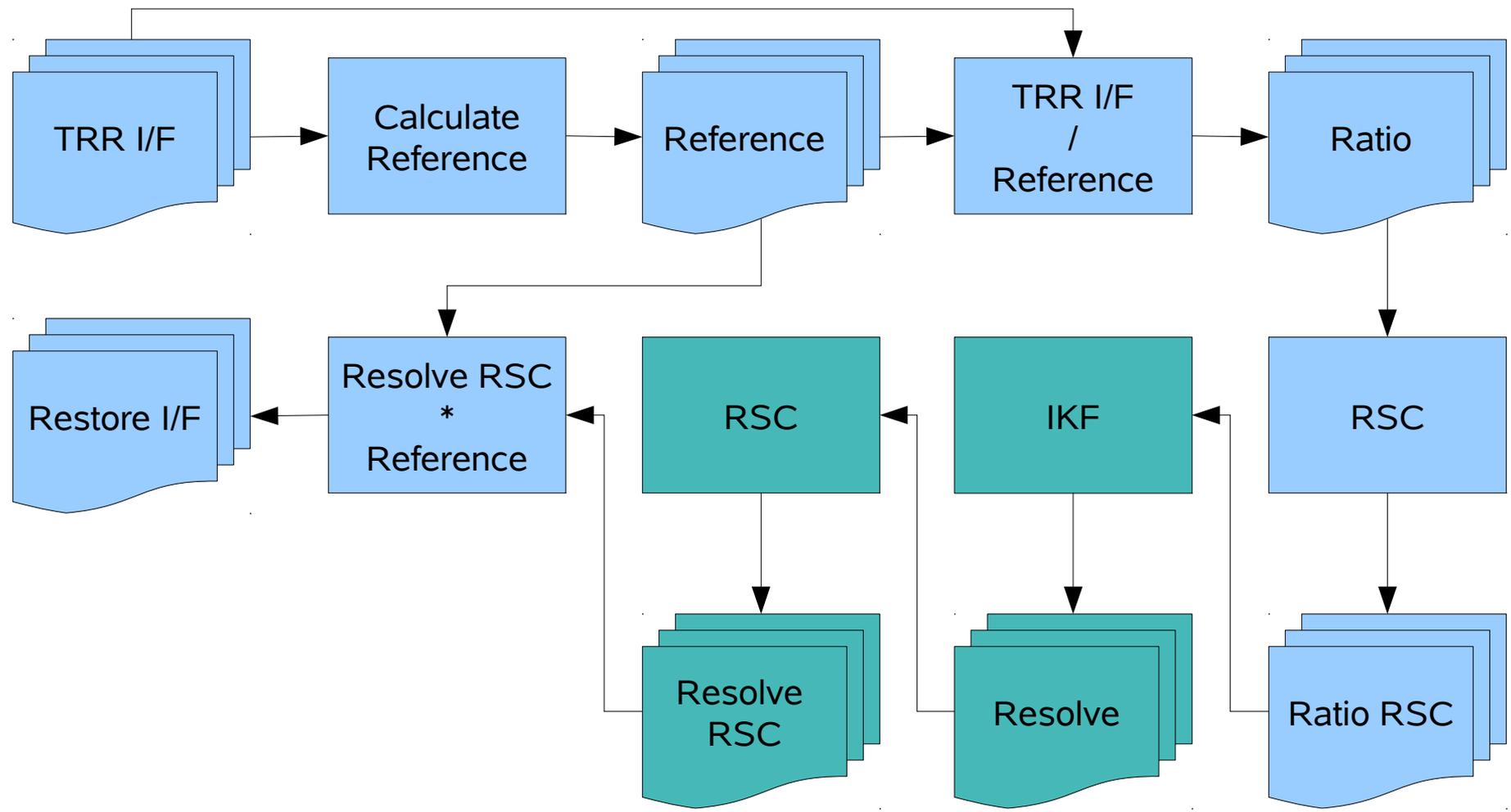




Walk through:
FRT000094F6
FRT00021BCB

Data Processing:
FRT0000C202



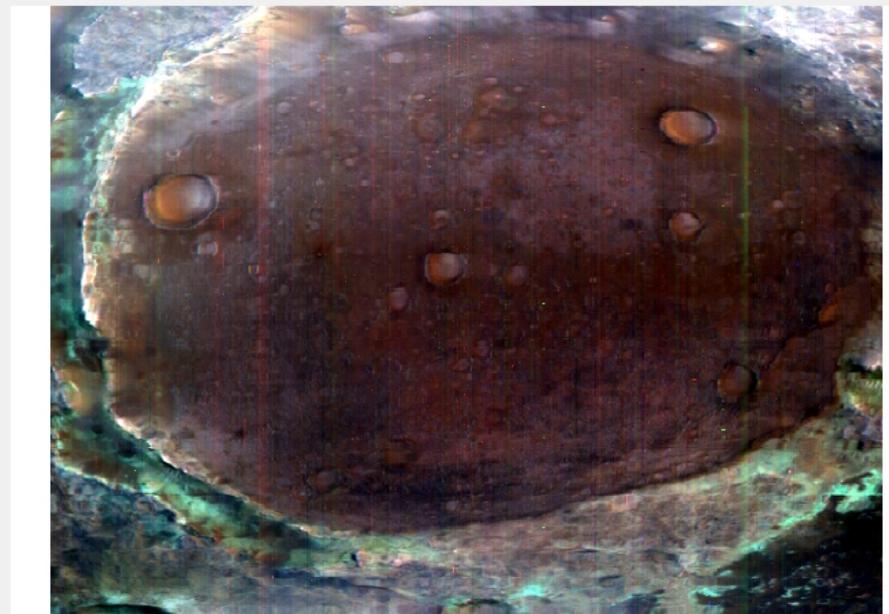
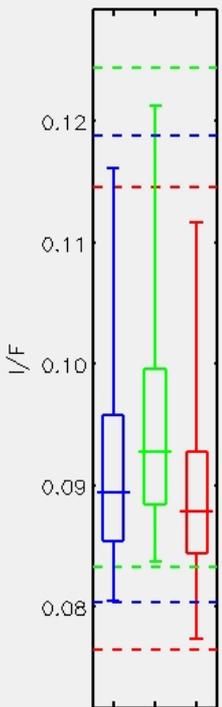


TRR I/F

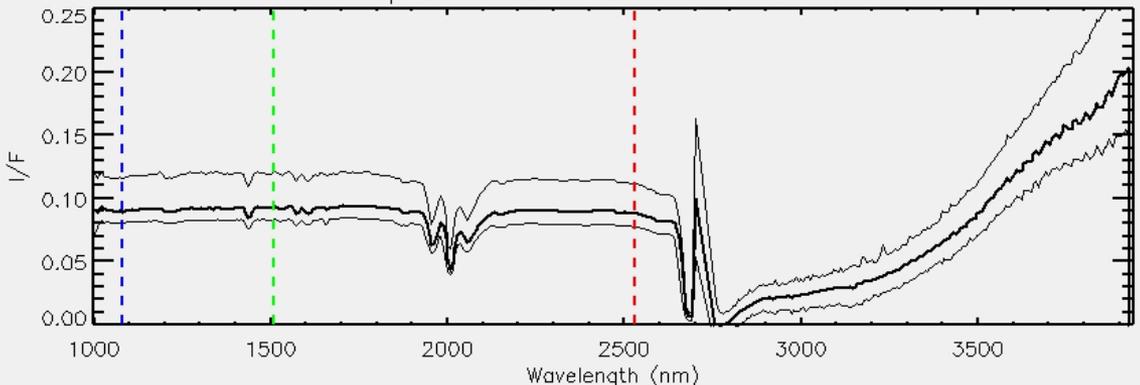
- Hyperspectral data filtering input image cube
- TRR3 radiance image cube transformed to I/F

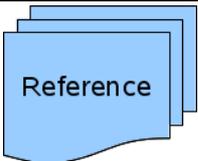
$$I/F = \text{Radiance} / [\text{Solar Irradiance} / (\pi * (\text{Solar Distance})^2)]$$

FRT0000C202 CRISM IR Composite



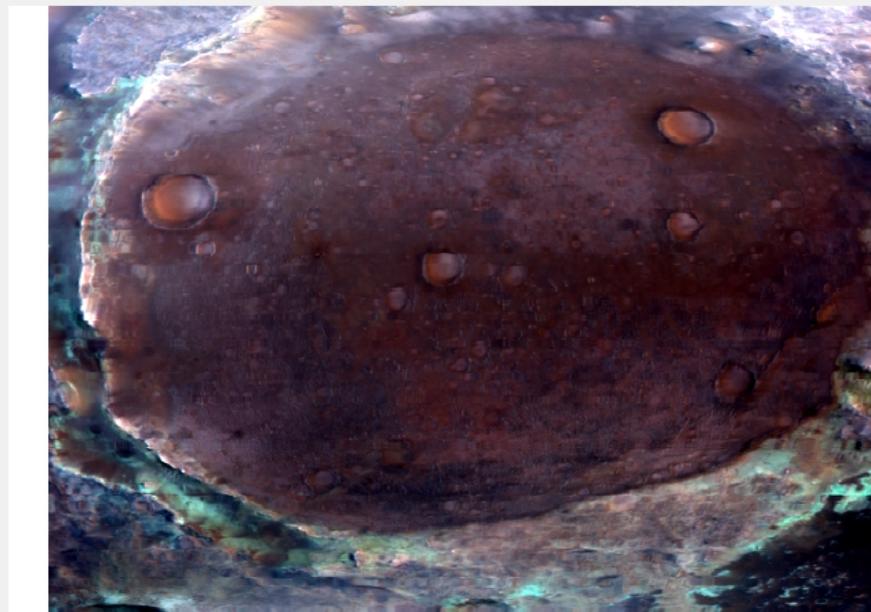
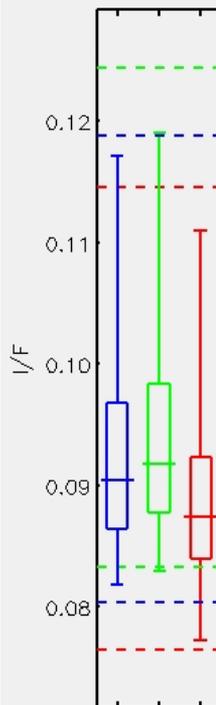
Spectral Median & Percentile Interval



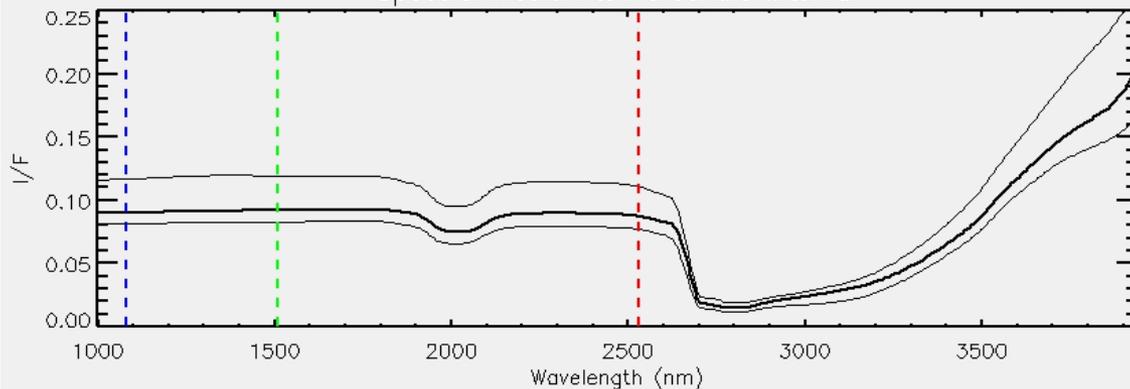


- Low spectral frequency / high spatial frequency transformation of input image cube
- Pristine representation of the spectral 'continuum' for each spatial pixel
- Any noise structure retained in the reference cube will be propagated without modification into the filtering result

FRT0000C202 CRISM IR Composite



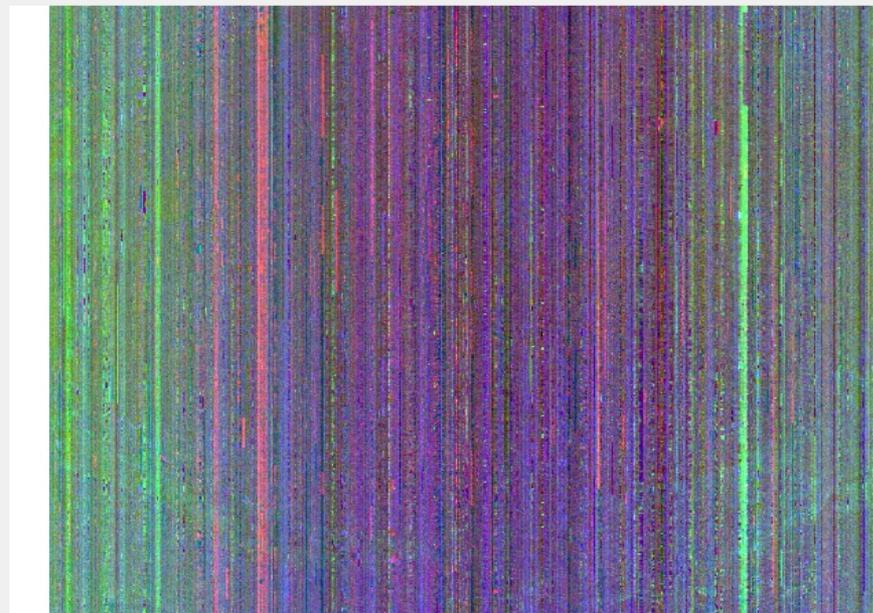
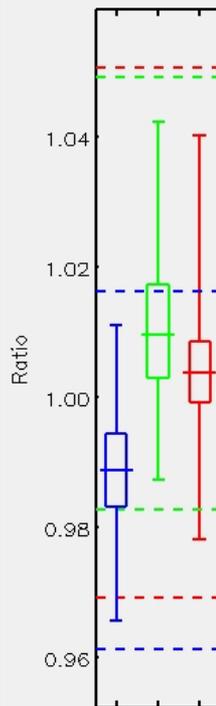
Spectral Median & Percentile Interval



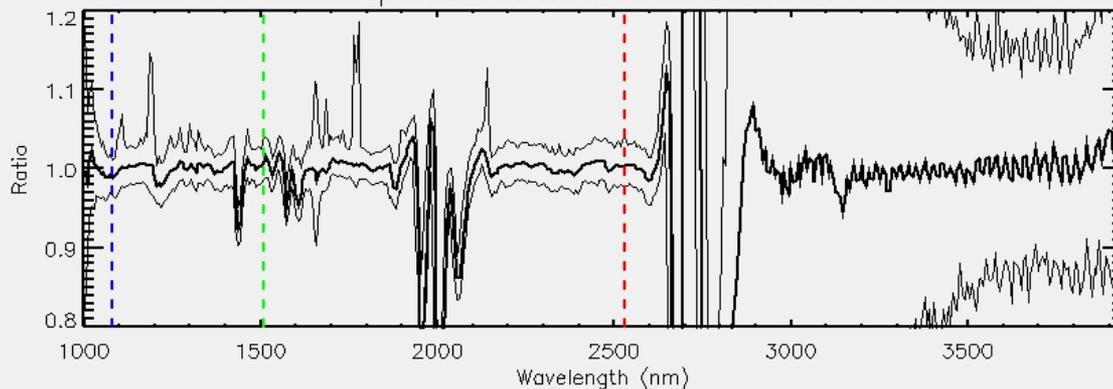
Ratio

- Ratio Image Cube = $\frac{[\text{Input Image Cube}]}{[\text{Reference Image Cube}]}$
- High frequency spectral and low frequency spatial information retained in ratio image cube
- Scene spectral variability and noise
- Cross-track smile structure

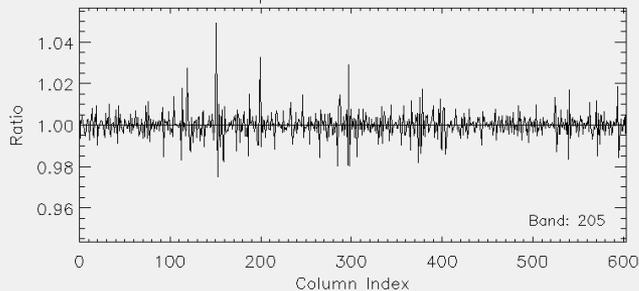
FRT0000C202 CRISM IR Composite



Spectral Median & Percentile Interval



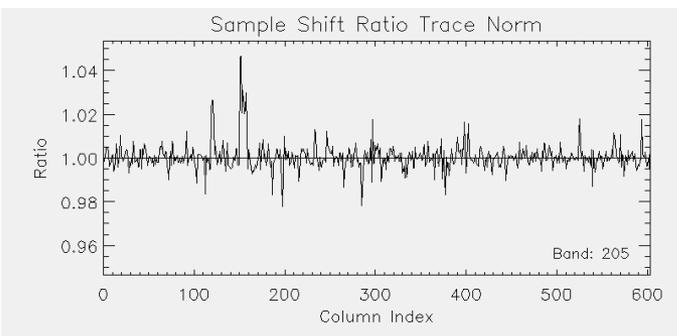
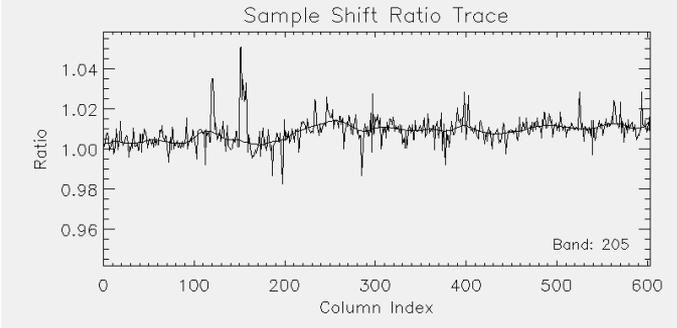
Sample Shift Ratio Median



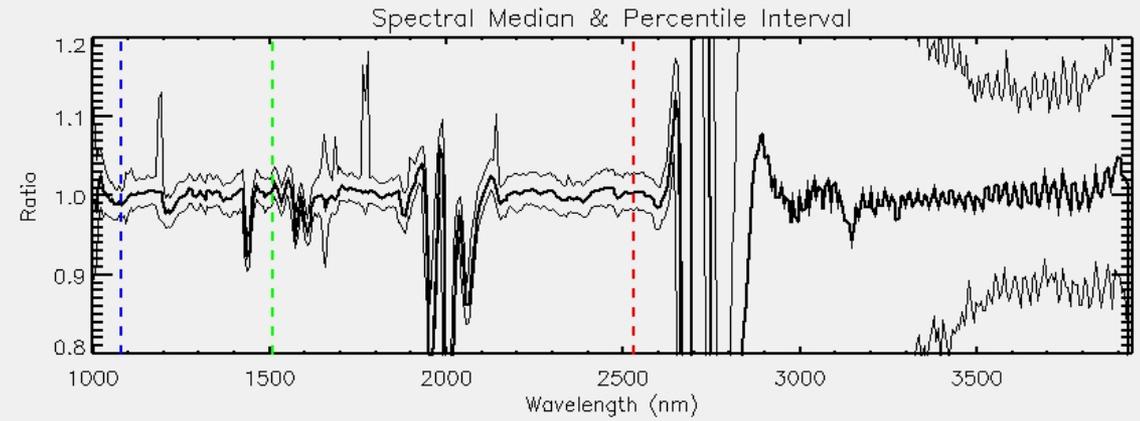
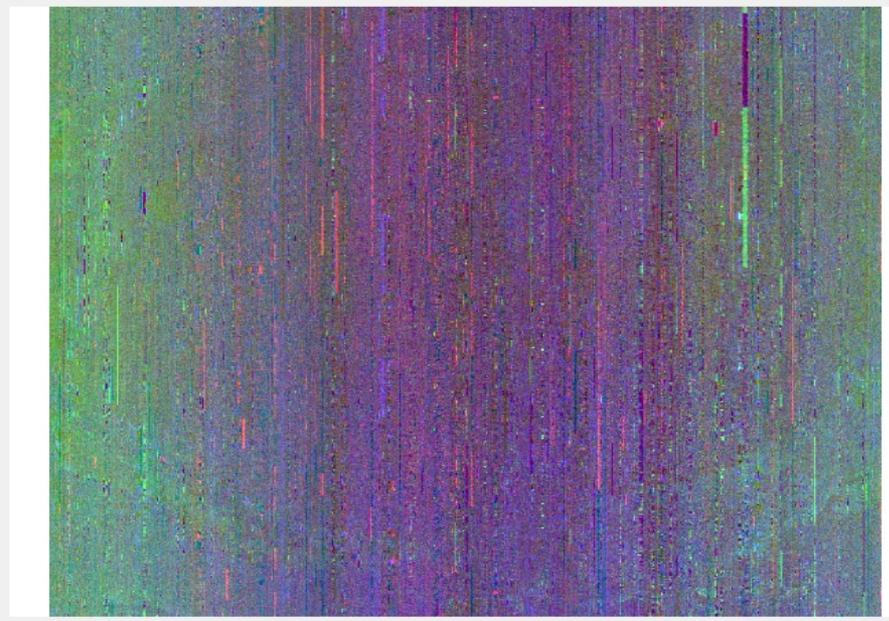
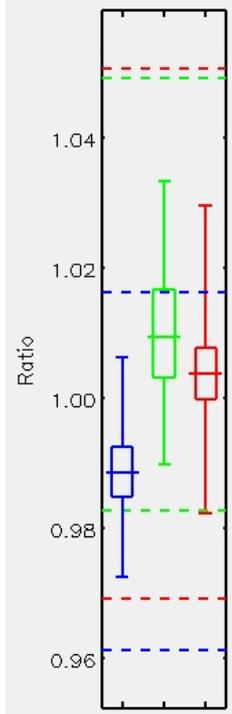
Ratio RSC

Ratio Shift Correction

- Characterizes systematic column-oriented radiometric residuals through the serial evaluation of inter-column ratio statistics
- Derived correction frame preserves statistically supported cross-track structure consistent with a reference model configuration



FRT0000C202 CRISM IR Composite

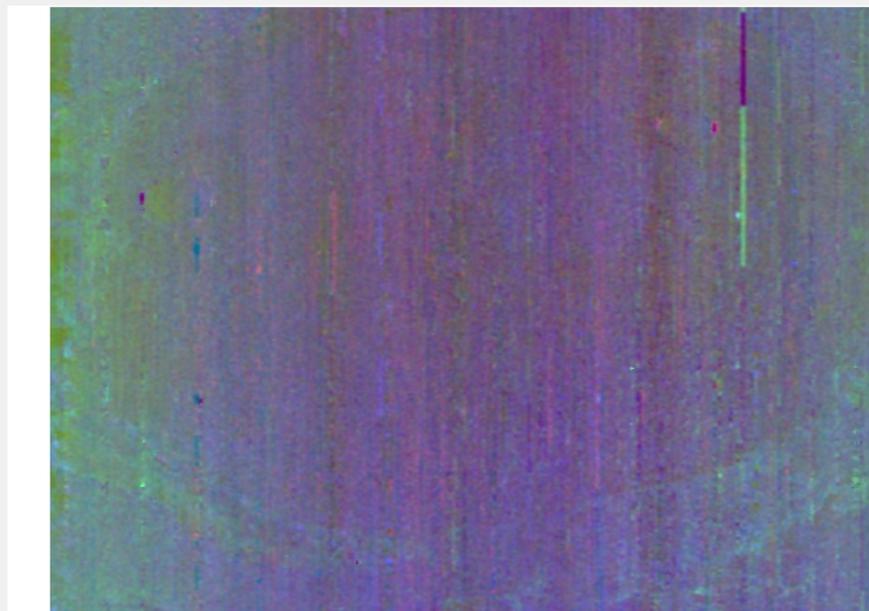
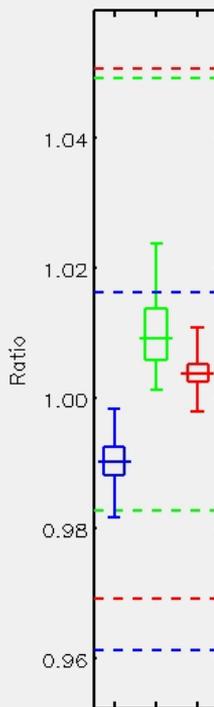


Resolve

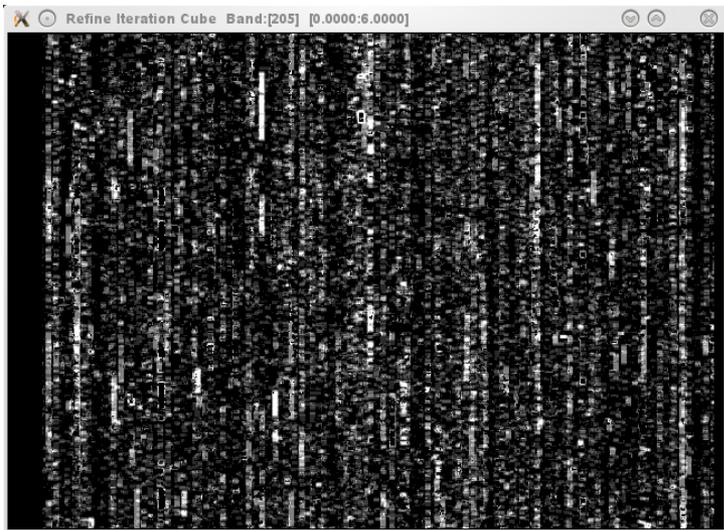
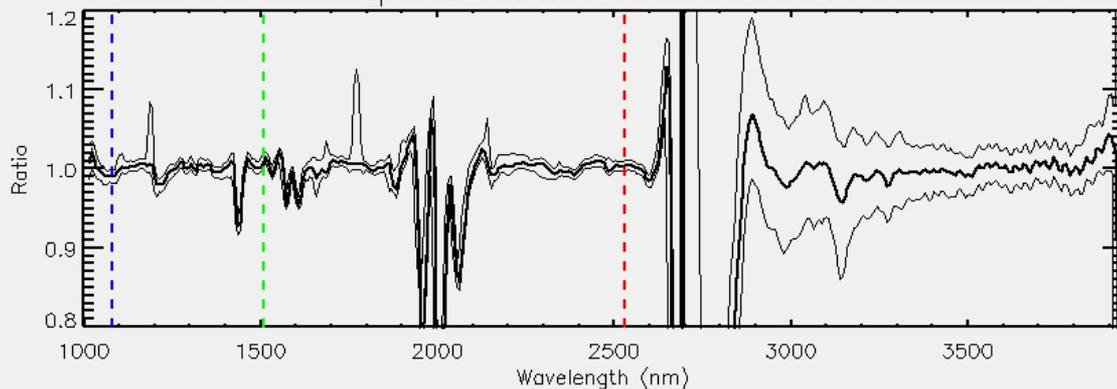
Iterative Kernel Filter

- Isolates stochastic noise through the iterative kernel-based application of a formal statistical outlier test
- Interpolation through outlier target pixels is performed by a proximity-weighted multidimensional polynomial model that excludes all kernel neighborhood outliers
- Kernel size = $[5,3,5]:[x,y,\lambda]$
- Confidence threshold and reference model configuration vary with wavelength

FRT0000C202 CRISM IR Composite

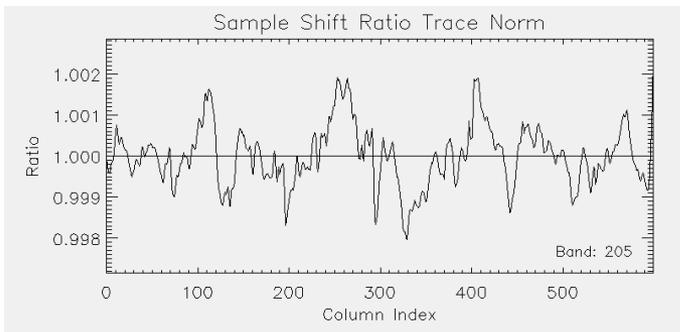
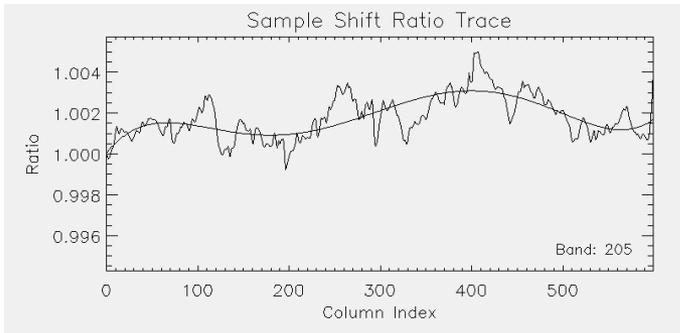
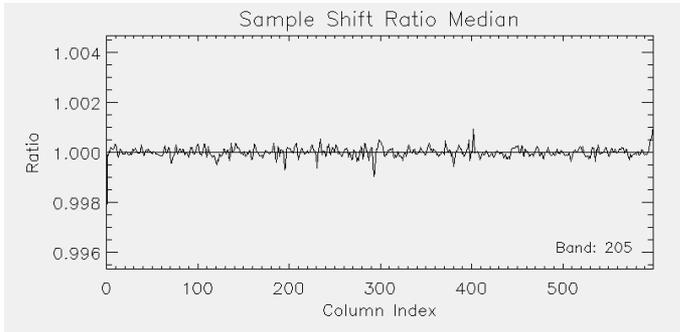


Spectral Median & Percentile Interval

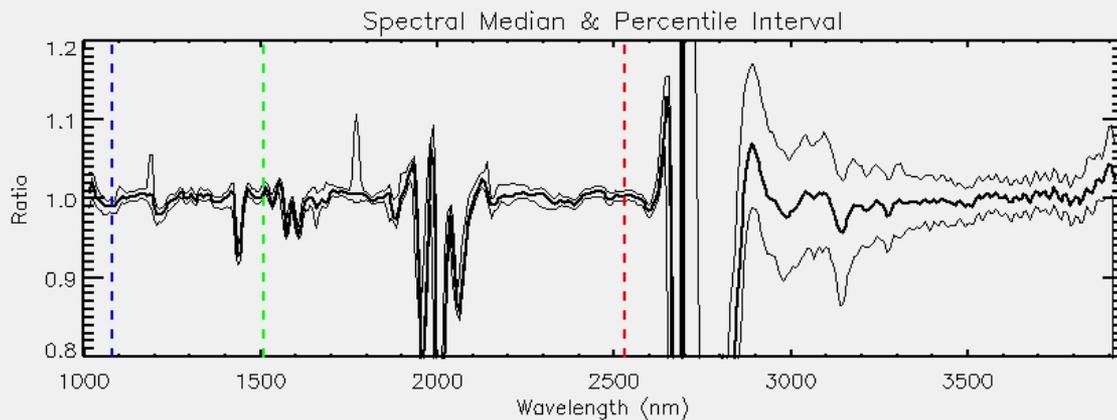
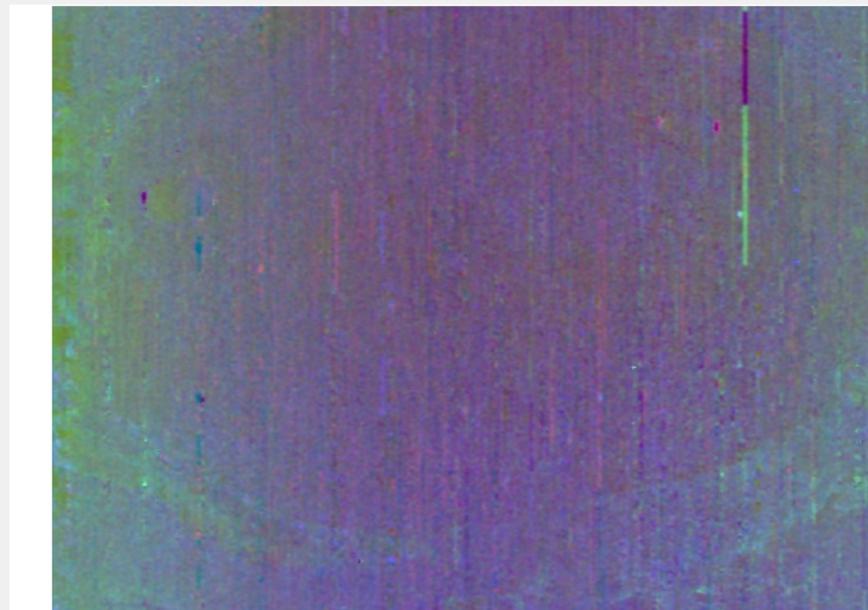
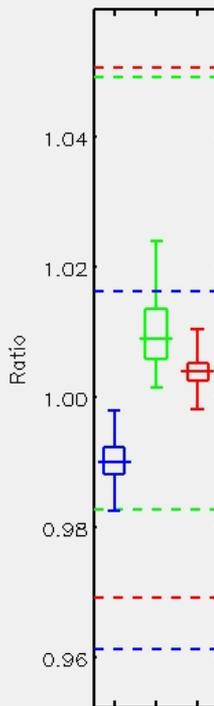


Resolve
RSC

Ratio Shift Correction



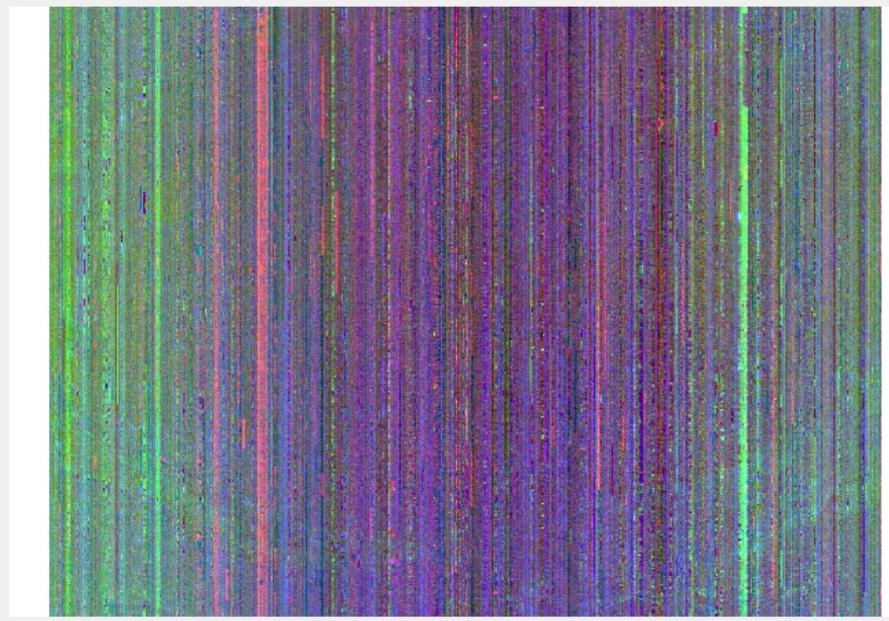
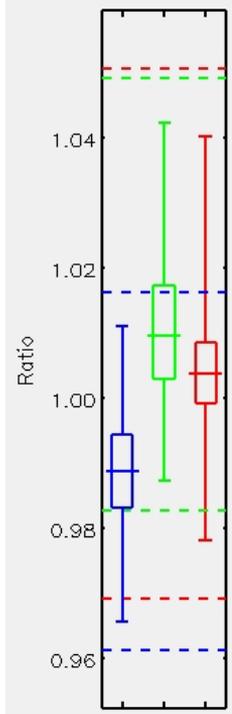
FRT0000C202 CRISM IR Composite



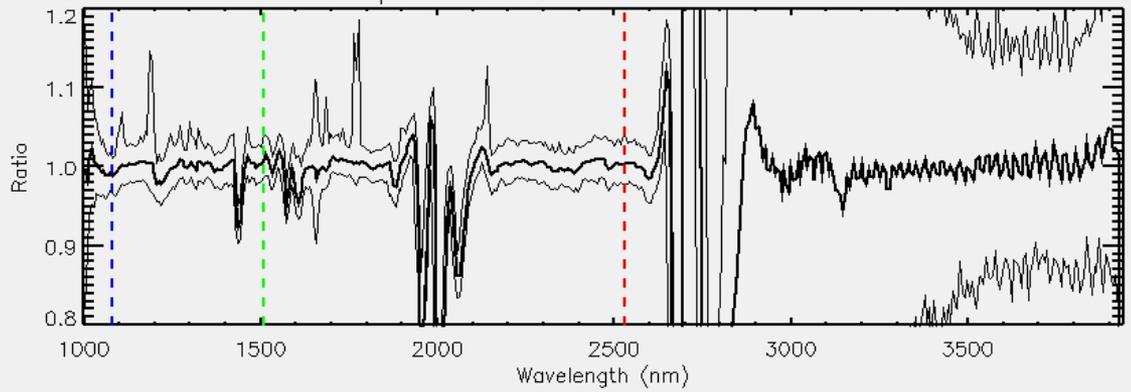
Ratio

- Ratio Image Cube = [Input Image Cube] / [Reference Image Cube]

FRT0000C202 CRISM IR Composite

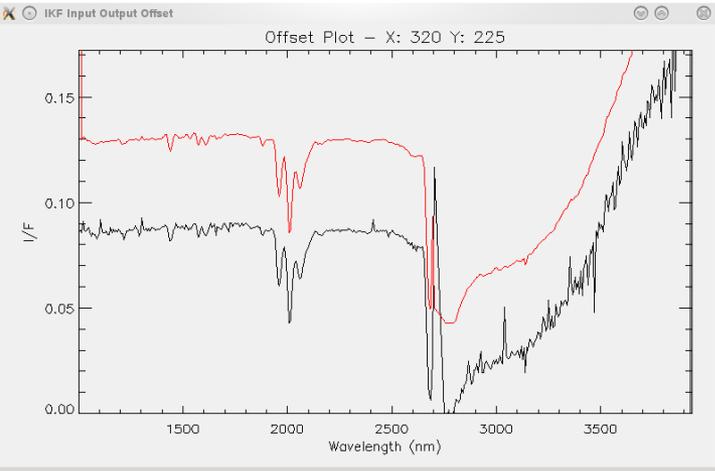


Spectral Median & Percentile Interval



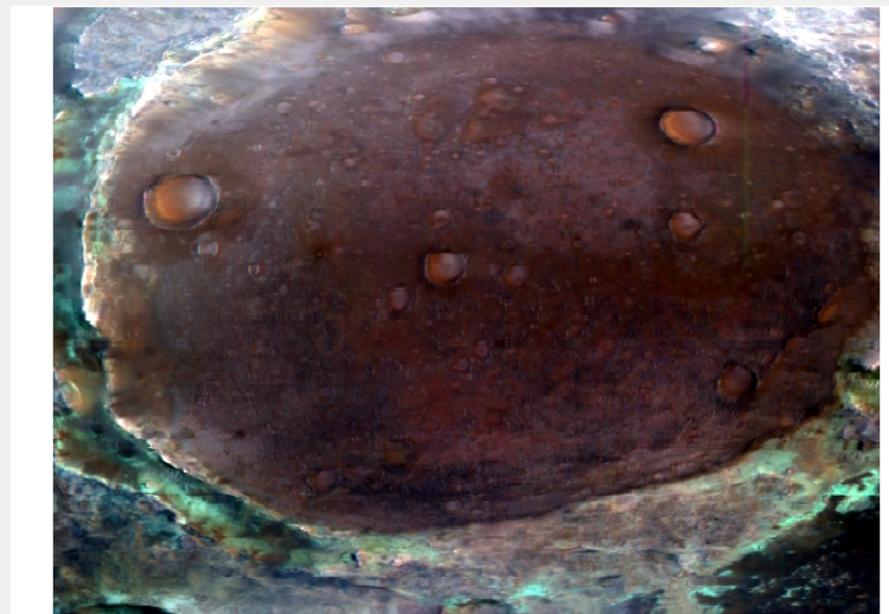
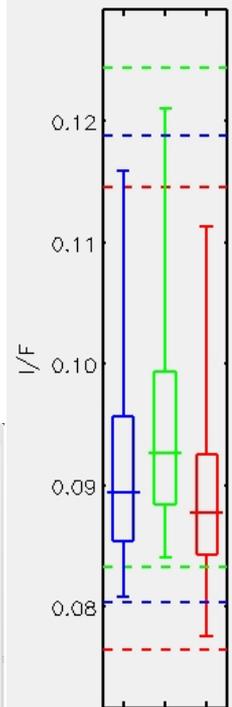
Restore I/F

- Restore Image Cube =
 [Resolve RSC Image Cube] *
 [Reference Image Cube]

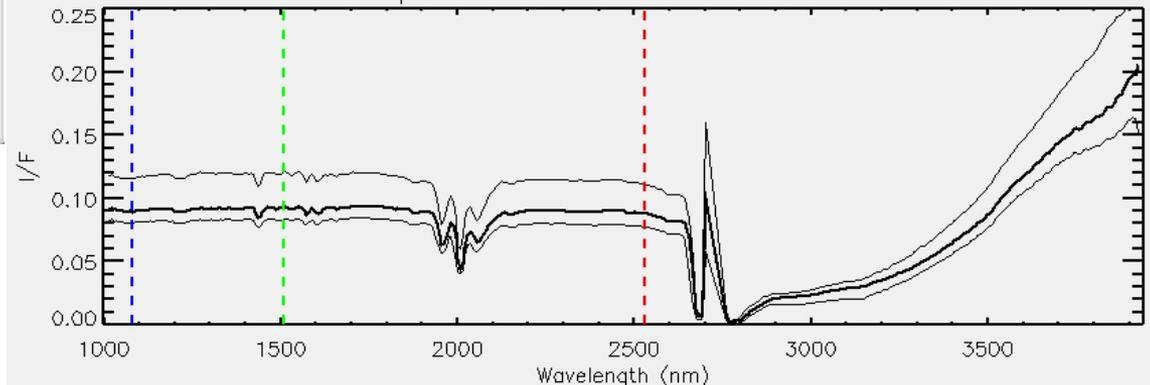


Single pixel input and output spectrum

FRT0000C202 CRISM IR Composite



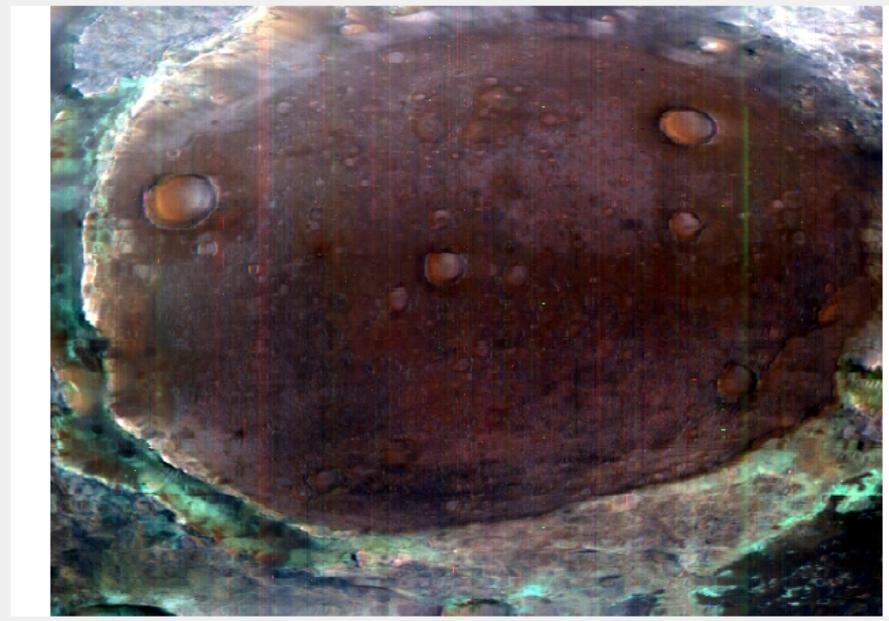
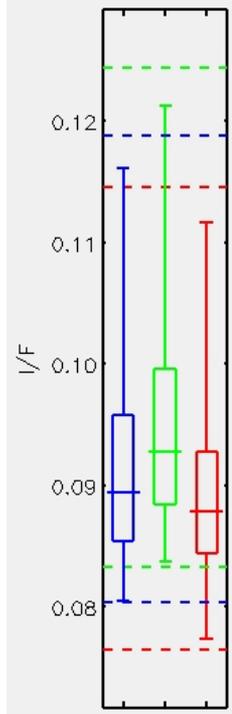
Spectral Median & Percentile Interval



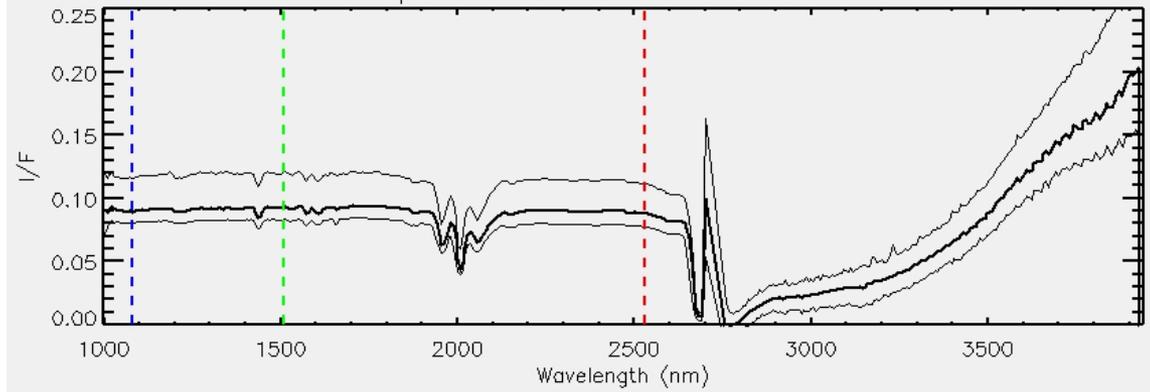
TRR I/F

- Hyperspectral data filtering input image cube
- TRR3 radiance image cube transformed to I/F

FRT0000C202 CRISM IR Composite

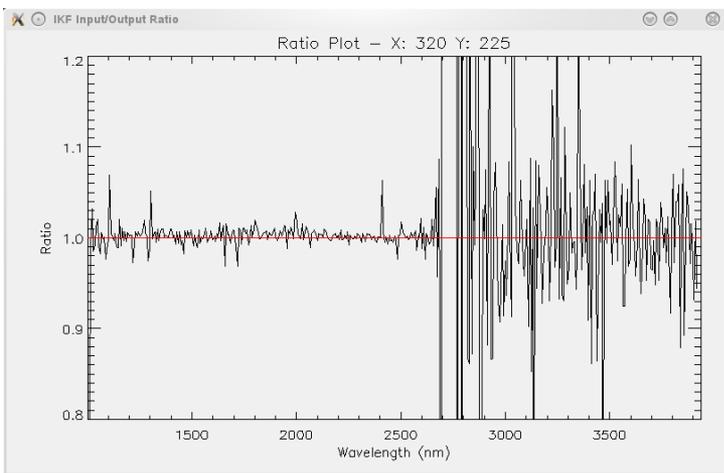
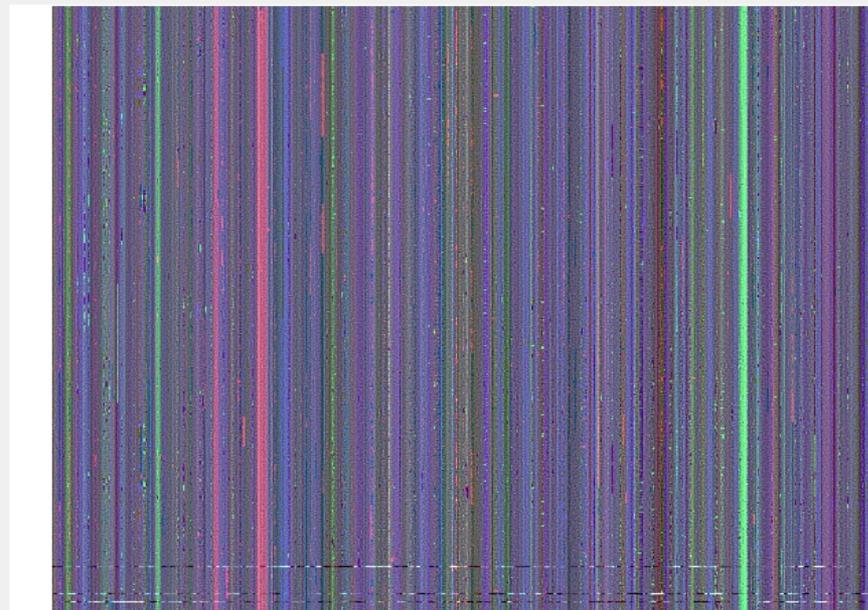
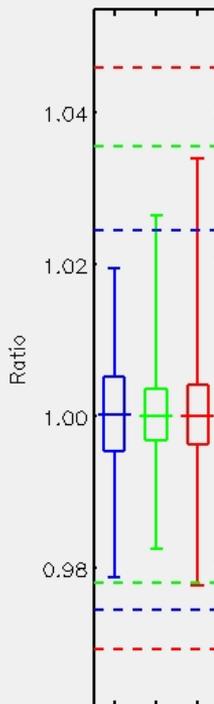


Spectral Median & Percentile Interval



- Input Image Cube / Output Image Cube
- Median input/output spectrum is nearly stationary
- RSC – I/O ratio structure that is consistent along an entire column
- IKF – All other I/O ratio structure

FRT0000C202 CRISM IR Composite



Single pixel input/output ratio spectrum

